Certification Report on

Specific Absorption Rate (SAR) Experimental Analysis on Body

Com-Net Ericsson Critical Radio Systems

Panther 300P

Test Date: 23 June, 2000

CNEB-PANTHER 300P-3472

51 Spectrum Way Nepean ON K2R 1E6
Tel: (613) 820-2730 Fax: (613) 820-4161
email: info@aprel.com

CERTIFICATION REPORT

Subject:	**Specific Absorption Rate (SAR) Experimental Analysis on Body**
Product:	FM Portable Radio
Model:	Panther 300P
Client:	Com-Net Ericsson Critical Radio Systems
Address:	3315 Old Forest Road Lynchburg, VA 24501 U.S.A.
Project #:	CNEB-PANTHER 300P-3472
Prepared by:	APREL Laboratories 51 Spectrum Way Nepean, Ontario K2R 1E6

Telecommunications Approval Board • Spectrum Sciences Institute • SAR Certified APREL Laboratories A065-Panther 300P

Tested by Delia M. Zapata, BSEE Date: Jun 28, 00

Submitted by Dr. Paul G. Cardinal, Director, Laboratories Date: 07 July 00

Approved by Dr. Jacek J. Wojcik, P. Eng. Date: July 7/2000

J. J. Wojcik

51 Spectrum Way
Nepean, Ontario, K2R 1E6

Tel. (613) 820-2730
Fax (613) 820 4161
e-mail: info@aprel.com

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51 Spectrum Way
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Tested by ____________________________ Date: ________________
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51 Spectrum Way
Nepean, Ontario, K2R 1E6
Tel. (613) 820-2730
Fax (613) 820 4161
e-mail: info@aprel.com

FCC ID:	OWDTR0003-A
Applicant:	Com-Net Ericsson Critical Radio Systems
Equipment:	FM Portable Radio
Model:	Panther 300P
Standard:	FCC 96 –326, Guidelines for Evaluating the Environmental Effects of Radio-Frequency Radiation

ENGINEERING SUMMARY

This report contains the results of the engineering evaluation performed on a Com-Net Ericsson model Panther 300P FM Portable Radio used on the body. The measurements were carried out in accordance with FCC 96-326. The FM Portable Radio was evaluated at its nominal high power level (4 W, 36 dBm) with 100% duty factor.

The FM Portable Radio was tested at low, middle and high frequencies (450.025 MHz, 469.975 MHz and 487.975 MHz, respectively), with the three types of antennas offered: ¼ wavelength whip (450-512 MHz) and two helical stub antennas (440-470 MHz and 470-512 MHz), with a belt clip attached on its back side and with the belt clip parallel to, and touching, the phantom. The maximum SAR was found to coincide with the peak performance RF output power of the middle channel (469.975 MHz) when using antenna G. Test data and graphs are presented in this report.

Based on the test results and on how the device will be used, it is certified that the product meets the requirements as set forth in the above specifications, for an occupational / controlled RF exposure environment for partial body exposure.

The results presented in this report relate only to the sample tested.

51 Spectrum Way
Nepean, Ontario, K2R 1E6

Tel. (613) 820-2730
Fax (613) 820 4161
e-mail: info@aprel.com

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51 Spectrum Way
Nepean, Ontario, K2R 1E6

Tel. (613) 820-2730
Fax (613) 820 4161
e-mail: info@aprel.com

1. INTRODUCTION

Tests were conducted to determine the Specific Absorption Rate (SAR) of a sample of a Com-Net Ericsson model Panther 300P FM Portable Radio. These tests were conducted at APREL Laboratories' facility located at 51 Spectrum Way, Nepean, Ontario, Canada. A view of the SAR measurement setup can be seen in Appendix A Figure 1. This report describes the results obtained.

2. APPLICABLE DOCUMENTS

The following documents are applicable to the work performed:

1) FCC 96-326, Guidelines for Evaluating the Environmental Effects of Radio-Frequency Radiation

2) ANSI/IEEE C95.1-1992, IEEE Standard for Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz to 300 GHz.

3) ANSI/IEEE C95.3-1992, IEEE Recommended Practice for the Measurement of Potentially Hazardous Electromagnetic Fields – RF and Microwave.

4) OET Bulletin 65 (Edition 97-01) Supplement C (Edition 97-01), "Evaluating Compliance with FCC Guidelines for Human Exposure to Radio Frequency Electromagnetic Fields".

3. EQUIPMENT UNDER TEST

- Com-Net Ericsson model Panther 300P FM Portable Radio, S/N P3-12, received on 22 June 2000.

The FM Portable Radio will be called DUT (device under test) in the following.

The DUT is a PTT device that was programmed to operate at 450.025 MHz (channels 1 and 4), 469.975 MHz (channels 2 and 5) and 487.975 MHz (channels 3 and 6) with an output power of 4W (channels 1, 2 and 3) or 1W (channels 4, 5 and 6).

51 Spectrum Way
Nepean, Ontario, K2R 1E6
Tel. (613) 820-2730
Fax (613) 820 4161
e-mail: info@aprel.com

The DUT was measured with a speaker / microphone (Com-Net Ericsson part # KRY101 1640/1) with three different types of antennas that may be attached to the right side at the top of the device. Antenna "G" is a $\lambda/4$ whip antenna (Com-Net Ericsson part # KRE1011223/12) that operates in the 450-512 MHz band; antenna "H" is a helical stub antenna (Com-Net Ericsson part # KRE1011219/12) that operates in the 440-470 MHz band; and antenna "I" is a helical stub antenna (Com-Net Ericsson part # KRE1011219/13) that operates in the 470-512 MHz band. A photograph of the DUT, speaker / microphone and antennas can be found in Appendix B. See the manufacturer's submission documentation for drawings and more design details.

4. TEST EQUIPMENT

- APREL Triangular Dosimetric Probe Model E-009, s/n 115, Asset # 301420
- CRS Robotics A255 articulated robot arm, s/n RA2750, Asset # 301335
- CRS Robotics C500 robotic system controller, s/n RC584, Asset # 301334
- HP 438A power meter, s/n 2502A01684, Asset # 301417
- HP 8482A power sensor, s/n 2652A1512B, Asset # 301418
- APREL F-1, flat manikin, s/n 001
- Tissue Recipe and Calibration Requirements, APREL procedure SSI/DRB-TP-D01-033

5. TEST METHODOLOGY

1. The test methodology utilised in the certification of the DUT complies with the requirements of FCC 96-326 and ANSI/IEEE C95.3-1992.
2. The E-field is measured with a small isotropic probe (output voltage proportional to E^2).
3. The probe is moved precisely from one point to the next using the robot (10 mm increments for wide area scanning, 5 mm increments for zoom scanning, and 2.5 mm increments for the final depth profile measurement).

51 Spectrum Way
Nepean, Ontario, K2R 1E6
Tel. (613) 820-2730
Fax (613) 820 4161
e-mail: info@aprel.com

4. The probe travels in the homogeneous liquid simulating human tissue. Appendix D contains information about the recipe and properties of the simulated tissue used for these measurements.

5. The liquid is contained in a manikin simulating a portion of the human body.

6. The DUT is positioned with its belt clip parallel to, and touching, the bottom of the phantom.

7. All tests were performed with either 1 W or 4 W from the sample DUT for the high, middle and low channels, under transmit conditions.

More detailed descriptions of the test method is given in Section 6 when appropriate.

6. TEST RESULTS

6.1. TRANSMITTER CHARACTERISTICS

The battery-powered DUT will consume energy from its batteries, which may affect the DUT's transmission characteristics. In order to gage this effect the output of the transmitter is sampled before and after each SAR run. In the case of this DUT, the conducted power was sampled. A power meter was connected to the antenna feed point. The following table shows the conducted RF power sampled before and after each of the six sets of data used for the worst case SAR in this report.

Scan		Conducted Power Readings (dBm)		D (dB)	Battery #
Type	**Height (mm)**	**Before**	**After**		
Area	2.5	12.30	12.13	0.17	2
Area	12.5	12.26	12.15	0.11	1
Zoom	2.5	12.31	12.37	-0.06	2
Zoom	7.5	12.54	12.40	0.14	3
Zoom	12.5	12.56	12.39	0.17	1
Depth	2.5 – 22.5	12.36	12.20	0.16	2

These readings do not include the 23.94 dB of attenuation, sensor correction factor, cable and adapter losses.

51 Spectrum Way
Nepean, Ontario, K2R 1E6
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Fax (613) 820 4161
e-mail: info@aprel.com

6.2. SAR MEASUREMENTS

1) RF exposure is expressed as a Specific Absorption Rate (SAR). SAR is calculated from the E-field, measured in a grid of test points as shown in Appendix A Figure 2. SAR is expressed as RF power per kilogram of mass, averaged in 10 grams of tissue for the extremities and 1 gram of tissue elsewhere.

2) The DUT was put into test mode for the SAR measurements by turning it on and rotating the dial beside the antenna to control the channel (channels 1 and 4: 450.025 MHz; channels 2 and 4: 469.975 MHz; channels 3 and 6: 487.975 MHz) and operating power (4W for channels 1, 2 and 3, and 1W for channels 4, 5 and 6).

3) Figure 3 in Appendix A shows a contour plot of the SAR measurements for the DUT (channel 2, 4W, 469.975 MHz, using antenna G). The presented values were taken 2.5 mm into the simulated tissue from the flat phantom's solid inner surface. Figures 1 and 2 in Appendix A show the phantom used in the measurements. A grid is shown inside of the phantom indicating the orientation of the x-y grid used, with the co-ordinates (0,0) on the top left (orange dot). The y-axis is positive towards the right and the x-axis is positive towards the bottom. In this position the antenna is located on top of the DUT with the antenna aligned with x=3 and the top of the knobs on y=15.

   A different presentation of the same data is shown in Appendix A Figure 4. This is a surface plot, where the measured SAR values provide the vertical dimension, which is useful as a visualisation aid.

   Similar data was obtained 12.5 mm into the simulated. These measurements are presented as a contour plot in Appendix A Figure 5 and surface plot in Figure 6.

   Figure 10 in Appendix A shows an overlay of the DUT's outlines, superimposed onto the contour plot previously shown as Figure 3.

   Figures 3 through 6 in Appendix A show that there is a dominant peak, in the contour plots, that diminishes in magnitude with depth into the tissue simulation.

51 Spectrum Way
Nepean, Ontario, K2R 1E6
Tel. (613) 820-2730
Fax (613) 820 4161
e-mail: info@aprel.com

4) Wide area scans were performed at 1W (to limit the stresses on the DUT) for the high, middle and low frequencies using the three antennas in their intended bands. Then wide area scans were performed at the maximum nominal output power (4 W) for the antenna producing the worst SAR in the preceding measurements (antenna G). These scans were done at 100% duty factor. The peak single point SAR for the scans were:

Antenna	Channel				Highest SAR [W/kg]
	#	L / M / H	Frequency	Output Power	
G	4	L	450.025 MHz	1W	1.94
G	5	M	469.975 MHz	1W	2.00
G	6	H	487.975 MHz	1W	2.02
H	4	L	450.025 MHz	1W	1.59
H	5	M	469.975 MHz	1W	1.22
I	5	M	469.975 MHz	1W	1.97
I	6	H	487.975 MHz	1W	1.77
G	1	L	450.025 MHz	4W	6.48
G	**2**	**M**	**469.975 MHz**	**4W**	**6.81**
G	3	H	487.975 MHz	4W	6.58

All subsequent testing was performed with the DUT using antenna G, transmitting on the middle channel (2, 469.975MHz) with the maximum nominal power of 4W.

5) The DUT was then explored on a refined 0.5 mm grid in three dimensions. Figures 7, 8 and 9 show the measurements made at 2.5, 7.5 and 12.5 mm respectively. The SAR value averaged over 1 gram was determined from these measurements by averaging the 27 points (3x3x3) comprising a 1 cm cube. The maximum SAR value measured averaged over 1 gram was determined from these measurements to be 5.05 W/kg.

6) To extrapolate the maximum SAR value averaged over 1 gram to the inner surface of the phantom a series of measurements were made at a few (x,y) co-ordinates within the refined grid as a function of depth, with 2.5 mm spacing. Figure 11 in Appendix A shows the data gathered and the exponential curves fit to them. The average exponential coefficient was determined to be (-0.0444± 0.0006) / mm.

51 Spectrum Way
Nepean, Ontario, K2R 1E6
Tel. (613) 820-2730
Fax (613) 820 4161
e-mail: info@aprel.com

7) The distance from the probe tip to the inner surface of the phantom for the lowest point is 2.5 mm. The distance from the probe tip to the tip of the measuring dipole within the APREL Triangular Dosimetric Probe Model E-009 is 2.3 mm. The total extrapolation distance is 4.8 mm, the sum of these two.

   Applying the exponential coefficient over the 4.8 mm to the maximum SAR value averaged over 1 gram that was determined previously, we obtain the maximum SAR value at the surface averaged over 1 gram, **6.25 W/kg.**

7. DISCUSSION

The factory tolerance for setting the power level of the FM Portable Radio is 4.26 ± 0.05 W. The DUT could then have an absolute maximum power of 4.31W. It was determined by proportional scaling of the maximum power to 4.31W that the device would produce an estimated maximum 1g SAR of 6.32 W/kg.

51 Spectrum Way
Nepean, Ontario, K2R 1E6
Tel. (613) 820-2730
Fax (613) 820 4161
e-mail: info@aprel.com

8. CONCLUSIONS

The maximum Specific Absorption Rate (SAR) averaged over 1 g, determined at 469.975 MHz (channel 2, M, 4W), of a Com-Net Ericsson model Panther 300P FM Portable Radio, is 6.32 W/kg. Since this is a PTT device, its maximum effective duty factor is 50%, resulting in an effective maximum 1g SAR of 3.16 W/kg. The overall margin of uncertainty for this measurement is ± 11.0 % (Appendix C). The SAR limit given in the FCC 96-326 safety guideline is 8 W/kg for occupational / controlled exposure. The product under investigation will be used in an occupational/controlled environment with user training, which will be indicated in the manufacturer's documentation.

Considering the above, this unit as tested, and as it will be marketed and used (with a user training), is found to be compliant with this requirement.

51 Spectrum Way
Nepean, Ontario, K2R 1E6
Tel. (613) 820-2730
Fax (613) 820 4161
e-mail: info@aprel.com

APPENDIX A

Figure 1(a) Setup

Figure 1(b) Setup close up

Figure 2

51 Spectrum Way
Nepean, Ontario, K2R 1E6
Tel. (613) 820-2730
Fax (613) 820 4161
e-mail: info@aprel.com

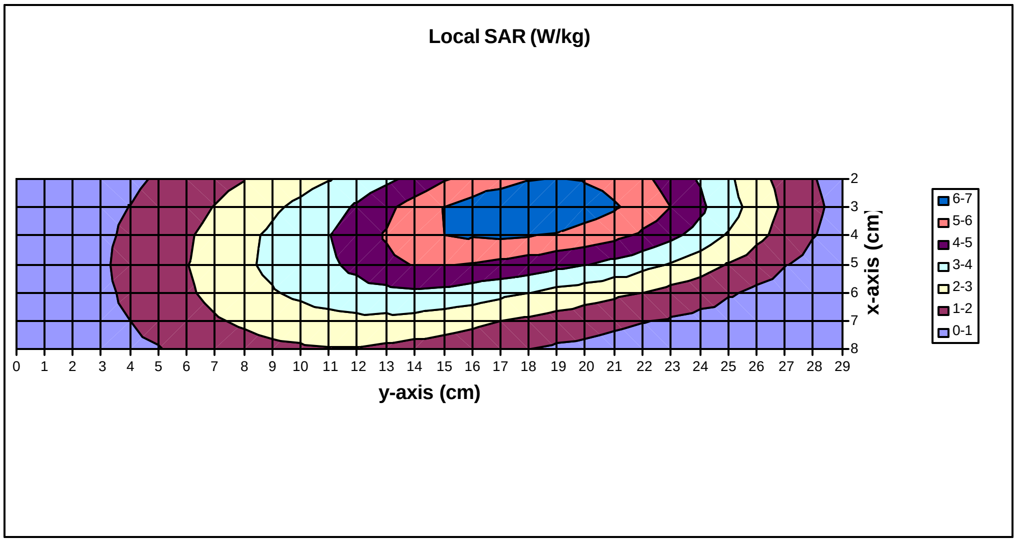

Figure 3. Area Scan 2.5mm Above Surface

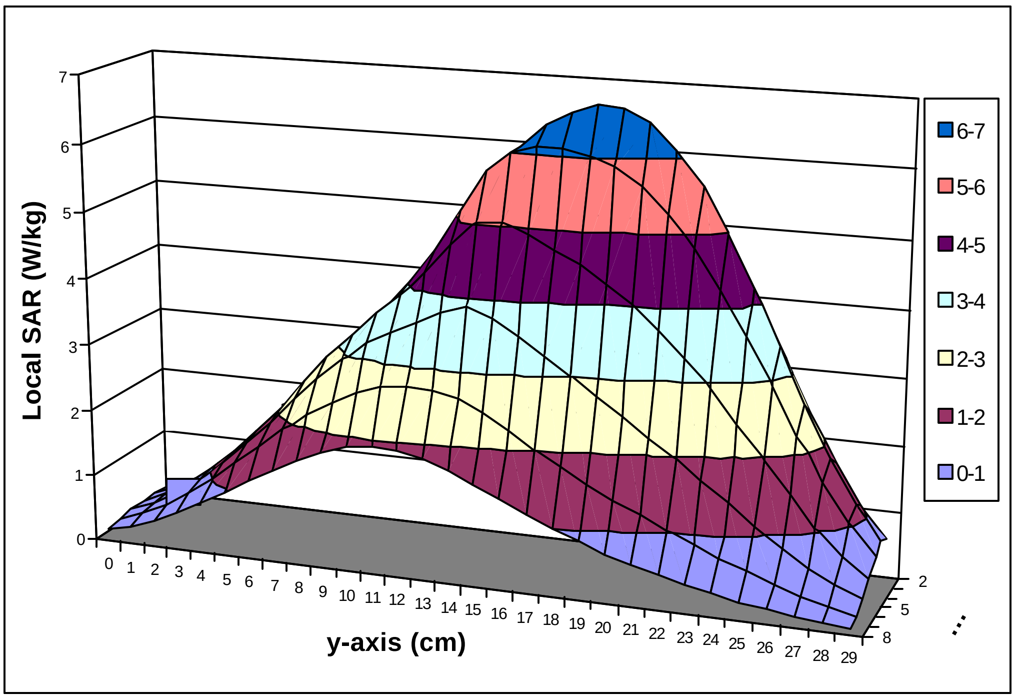

Figure 4. Area Scan 2.5mm Above Surface

51 Spectrum Way
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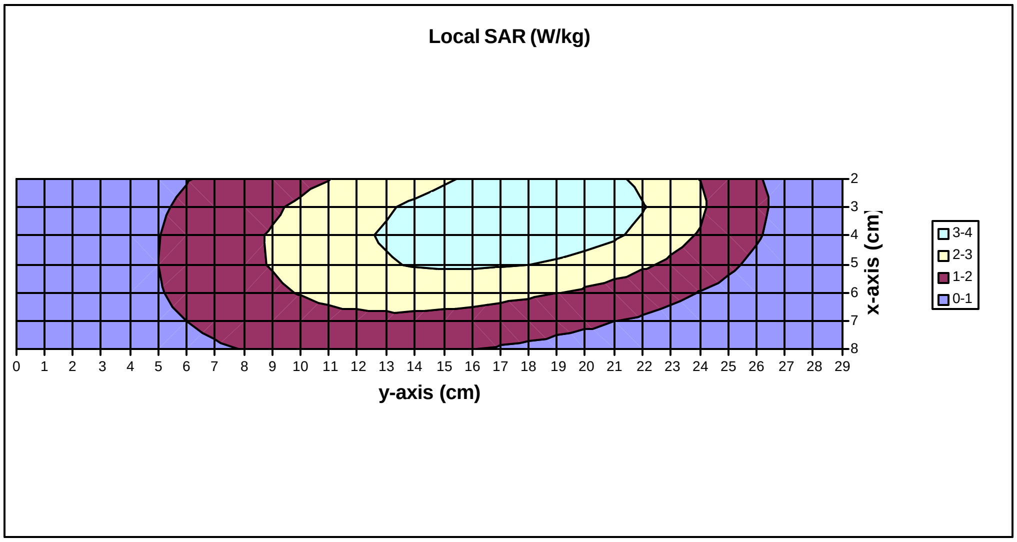

Figure 5. Area Scan 12.5mm Above Surface

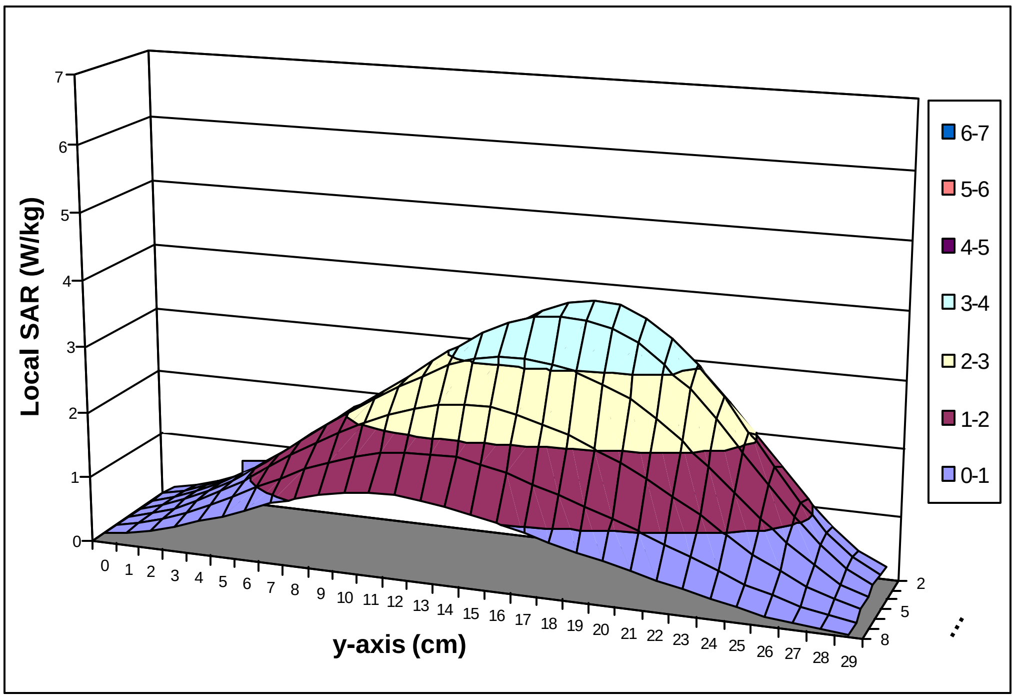

Figure 6. Area Scan 12.5mm Above Surface

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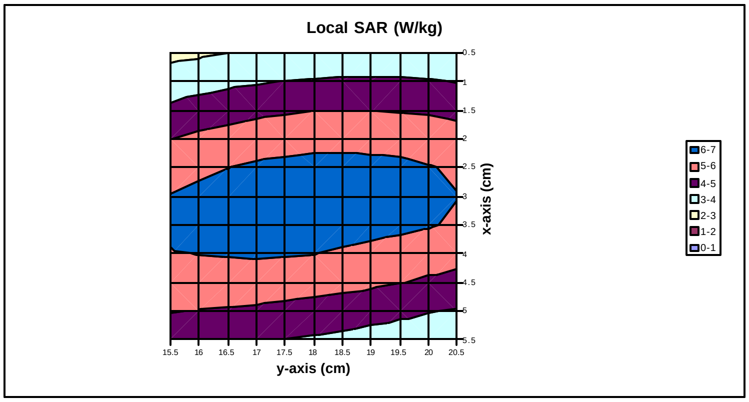

Figure 7. Zoom Scan 2.5mm Above Phantom Surface

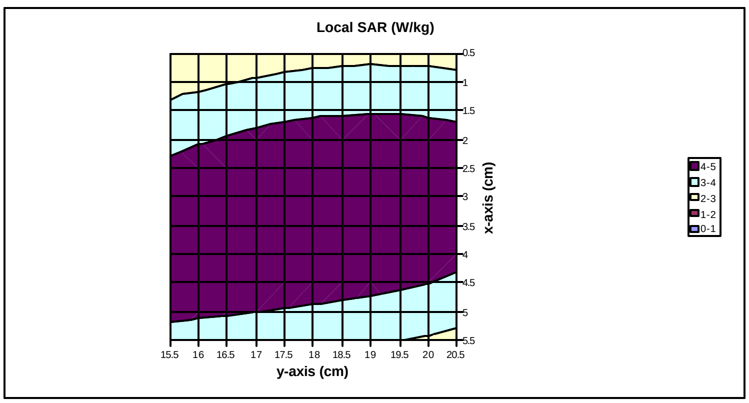

Figure 8. Zoom Scan 7.5mm Above Phantom Surface

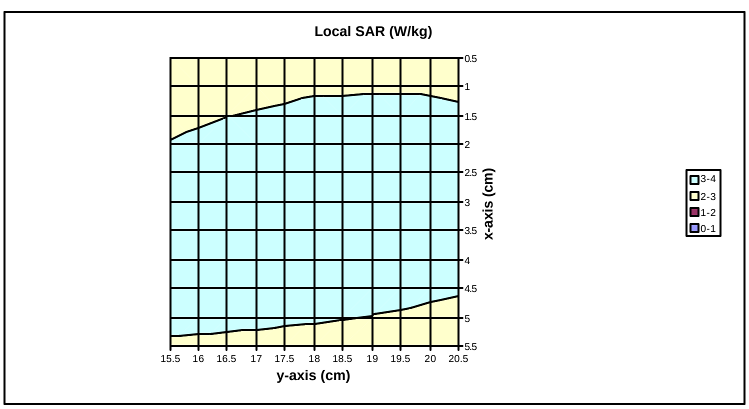

Figure 9. Zoom Scan 12.5mm Above Phantom Surface

51 Spectrum Way
Nepean, Ontario, K2R 1E6
Tel. (613) 820-2730
Fax (613) 820 4161
e-mail: info@aprel.com

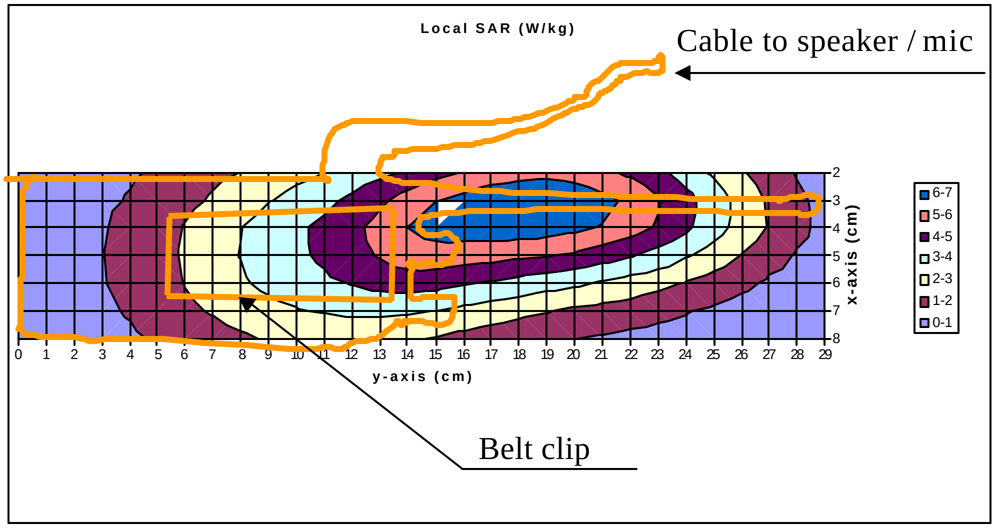

Figure 10

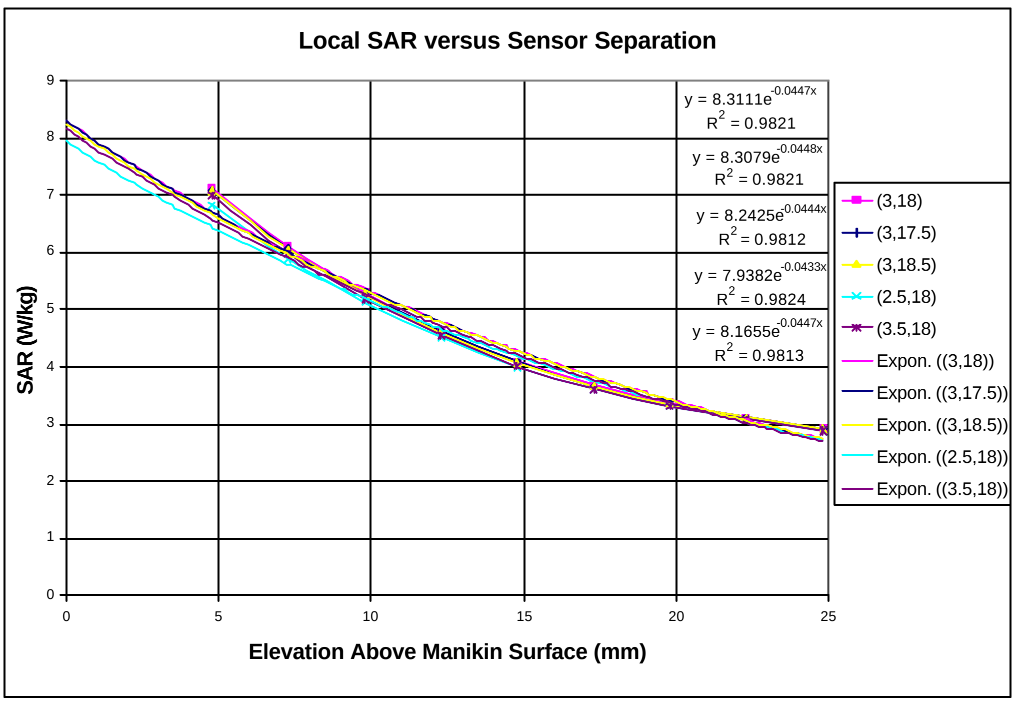

Figure 11

51 Spectrum Way
Nepean, Ontario, K2R 1E6

Tel. (613) 820-2730
Fax (613) 820 4161
e-mail: info@aprel.com

APPENDIX B

Manufacturer's Antenna and Speaker Specifications

Antenna "I"

Antenna "H"

Antenna "G"

Antenna "G" is a λ/4 whip antenna (Com-Net Ericsson part # KRE1011223/12) that operates in the 450-512 MHz band (channels 1 to 6)

Antenna "H" is a helical stub spring whip antenna (Com-Net Ericsson part # KRE1011219/12) that operates in the 440-470 MHz band (channels 1, 2, 4 and 5)

Antenna "I" is a helical stub spring whip antenna (Com-Net Ericsson part # KRE1011219/13) that operates in the 470-512 MHz band (channels 2, 3, 5 and 6)

(See manufacturer's submission documentation for drawings and more design details)

51 Spectrum Way
Nepean, Ontario, K2R 1E6
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e-mail: info@aprel.com

APPENDIX C

Uncertainty Budget

Uncertainties Contributing to the Overall Uncertainty

Type of Uncertainty	Specific to	Uncertainty	
Power variation due to battery condition	phone	2.0%	
Extrapolation due to curve fit of SAR vs depth	phone	2.8%	
Extrapolation due to depth measurement	setup	2.2%	
Conductivity	setup	6.0%	
Density	setup	2.6%	
Tissue enhancement factor	setup	7.0%	
Voltage measurement	setup	1.0%	
Probe sensitivity factor	setup	3.5%	
		11.0%	**RSS**

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51 Spectrum Way
Nepean, Ontario, K2R 1E6
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Fax (613) 820 4161
e-mail: info@aprel.com

APPENDIX D

Simulated Muscle Tissue Material and Calibration Technique

The mixture used was based on that presented SSI/DRB-TP-D01-033, “Tissue Recipe and Calibration Requirements”.

De-ionised water	52.8 %
Sugar	45.3 %
Salt	1.5 %
HEC	0.3 %
Bactericide	0.1 %

Mass density, ρ — 1.30 g/ml
(The density used to determine SAR from the measurements was the recommended 1040 kg/m^3 found in Appendix C of Supplement C to OET Bulletin 65, Edition 97-01)

Dielectric parameters of the simulated tissue material were determined using a Hewlett Packard 8510 Network Analyser, a Hewlett Packard 809B Slotted Line Carriage, and an APREL SLP-001 Slotted Line Probe.

The dielectric properties at 835 MHz, where the tissue is maintained, are:

	APREL	OET 65 Supplement	Δ / % (OET)
Dielectric constant, ε_r	58.5	56.11	4.2%
Conductivity, σ/ [S/m]	1.03	0.946	8.8%
Tissue Conversion Factor, γ	7.8	-	-

The dielectric properties at 470 MHz are:

	APREL	OET 65 Supplement	Δ / % (OET)
Dielectric constant, ε_r	61.5	57.49	16.73%
Conductivity, σ/ [S/m]	0.81	0.836	0.65%
Tissue Conversion Factor, γ	12.3	-	-

51 Spectrum Way
Nepean, Ontario, K2R 1E6
Tel. (613) 820-2730
Fax (613) 820 4161
e-mail: info@aprel.com

SIMULATION FLUID #	981126-M
CALIBRATION DATE	22-Jun-00
CALIBRATED BY	KOD
Frequency Range	100MHz-1GHz
Frequency Calibrated	470MHz
Tissue Type	Muscle

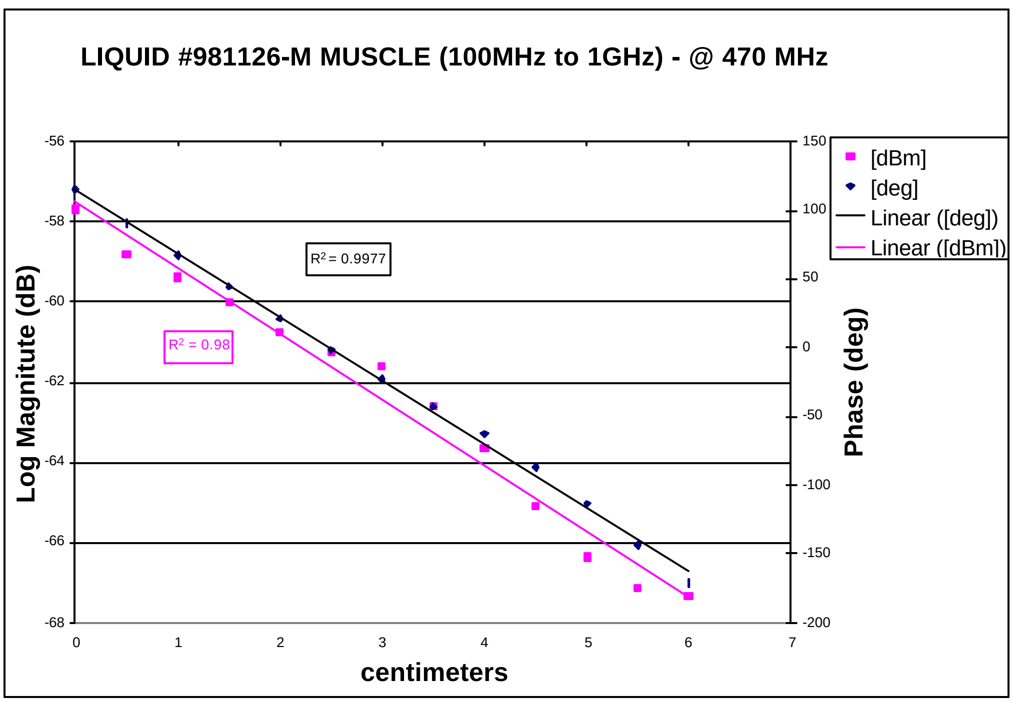
NOTE: THIS TISSUE WAS CALIBRATED AT 835 MHz

Position [cm]	Amplitude [dBm]	Phase [deg]	[deg]
0	-57.7	114.9	114.9
0.5	-58.8	91.2	91.2
1	-59.4	67.02	67.02
1.5	-59.99	44.3	44.3
2	-60.75	21.01	21.01
2.5	-61.24	-1.2	-1.2
3	-61.62	-22.3	-22.3
3.5	-62.62	-42.5	-42.5
4	-63.65	-62.35	-62.35
4.5	-65.07	-86.94	-86.94
5	-66.37	-113.55	-113.55
5.5	-67.13	-143	-143
6	-67.33	-171.16	-171.16

ΔdB_1	-3.92	Δdeg_1	-137.2
ΔdB_2	-3.82	Δdeg_2	-133.7
ΔdB_3	-4.25	Δdeg_3	-129.37
ΔdB_4	-5.08	Δdeg_4	-131.24
ΔdB_5	-5.62	Δdeg_5	-134.56
ΔdB_6	-5.89	Δdeg_6	-141.8
ΔdB_7	-5.71	Δdeg_7	-148.86
ΔdB_{AVG} [dB]	-4.90	$Ddeg_{AVG}$ [deg]	-136.6757143
dB_{AVG} (α_{AVG}) [dB/cm]	-1.63	deg_{AVG} (β_{AVG}) [deg/cm]	-45.55857143
(α_{AVG}) [NP/cm]	-0.187989626	(β_{AVG}) [rad/cm]	-0.795147074

f [Hz]	4.70E+08
μ [H/cm]	1.25664E-08
ε_o [F/cm]	8.854E-14

			Δ%
ε_r	61.5		7.01%
$\sigma_{effective}$	0.81	S/m	-3.64%



51 Spectrum Way
Nepean, Ontario, K2R 1E6

Tel. (613) 820-2730
Fax (613) 820 4161
e-mail: info@aprel.com

450 MHz Data (Heike & Tony) Muscle with E-115

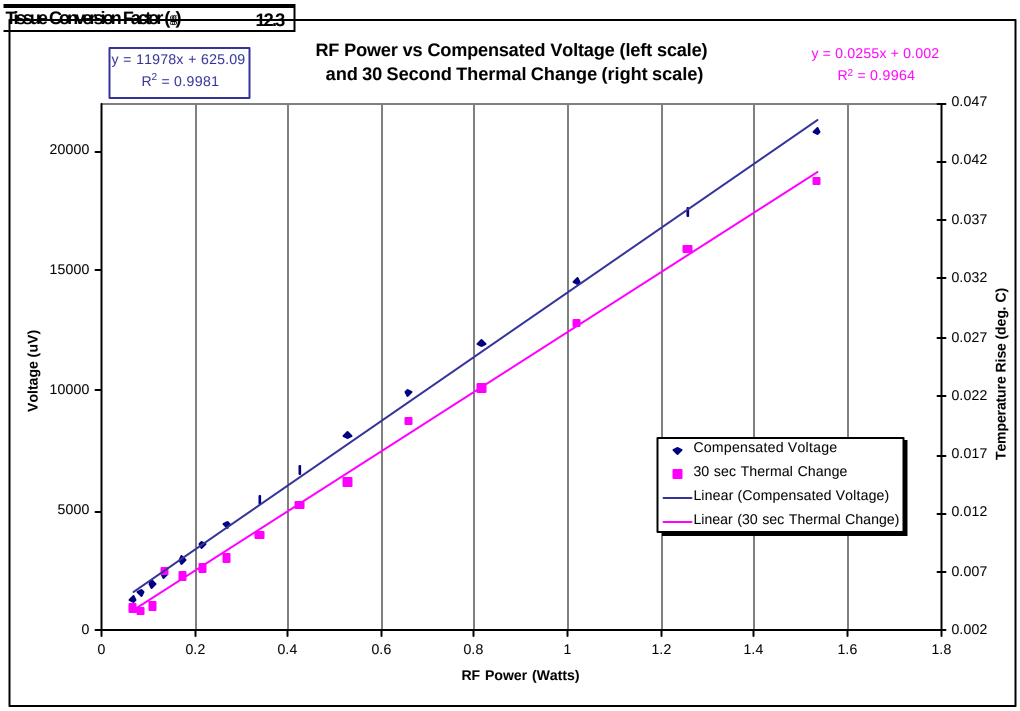
						deltaT	Sum		Thermal
RF Power			Ch0	Ch1	Ch2	(30 sec)	Vi/Ei		SAR
W	dBm	R&S	uV	uV	uV	deg. C			W/kg
0.068865	18.38	-32.61	562	732	1855	0.0039	1308.39		0.36
0.086298	19.36	-31.63	659	879	2271	0.0037	1583.06		0.34
0.109144	20.38	-30.61	806	1074	2832	0.0041	1958.84		0.38
0.136773	21.36	-29.63	952	1294	3491	0.0071	2385.71		0.66
0.17378	22.4	-28.59	1172	1587	4346	0.0067	2955.09		0.62
0.21677	23.36	-27.63	1416	1929	5322	0.0073	3605.12		0.68
0.270396	24.32	-26.67	1709	2344	6567	0.0082	4418.37		0.76
0.338844	25.3	-25.69	2100	2881	8081	0.0102	5434.42		0.94
0.42658	26.3	-24.69	2563	3564	9985	0.0127	6703.47		1.17
0.529663	27.24	-23.75	3125	4346	12134	0.0147	8156.42		1.36
0.657658	28.18	-22.81	3833	5298	14697	0.0199	9912.45		1.84
0.816582	29.12	-21.87	4663	6470	17700	0.0227	11992.6		2.10
1.018591	30.08	-20.91	5713	7910	21411	0.0282	14569.9		2.61
1.25603	30.99	-20	6958	9595	25488	0.0346	17479.8		3.20
1.534617	31.86	-19.13	8398	11548	30151	0.0404	20824.9		3.74

Directional Coupler factor 30.99 dB (Asset 100251 cal file data (Janusz, 21 Jul 96))
Additional inline attenuation 20 dB

Sensitivity (e) 1.624 1.677 1.572 - Sensor Sensitivity in mV/ (mW/cm^2) HW 5
η = 1.50 e 2.436 2.5155 2.358

Density	1.3	g/cm^3	1300	kg/m^3	-Tony, summer 99	
Conductivity	8	mS/cm	0.8	S/m	- Heike 8-Jul-99	
Heat Capacity (c)	2.775	J/C/g	2775	J/C/kg		
Exposure Time	30	seconds	30	seconds		
Slope of Measure Voltage (m_V)	13445.4	uV/W	0.01345	V/W		
- standard error or m_V	162.323	uV/W	0.00016	V/W		1.2%
Slope of Measure Temp Change (m_T)	0.02549	C/W	0.02549	C/W		
- standard error or m_T	0.00043	C/W	0.00043	C/W		1.7%

Tissue Conversion Factor (γ) 12.3

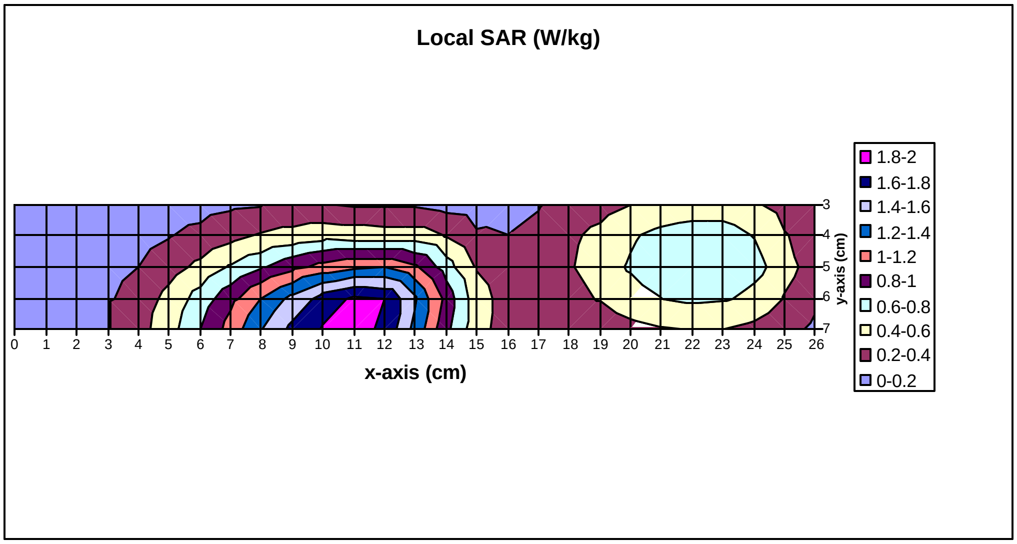


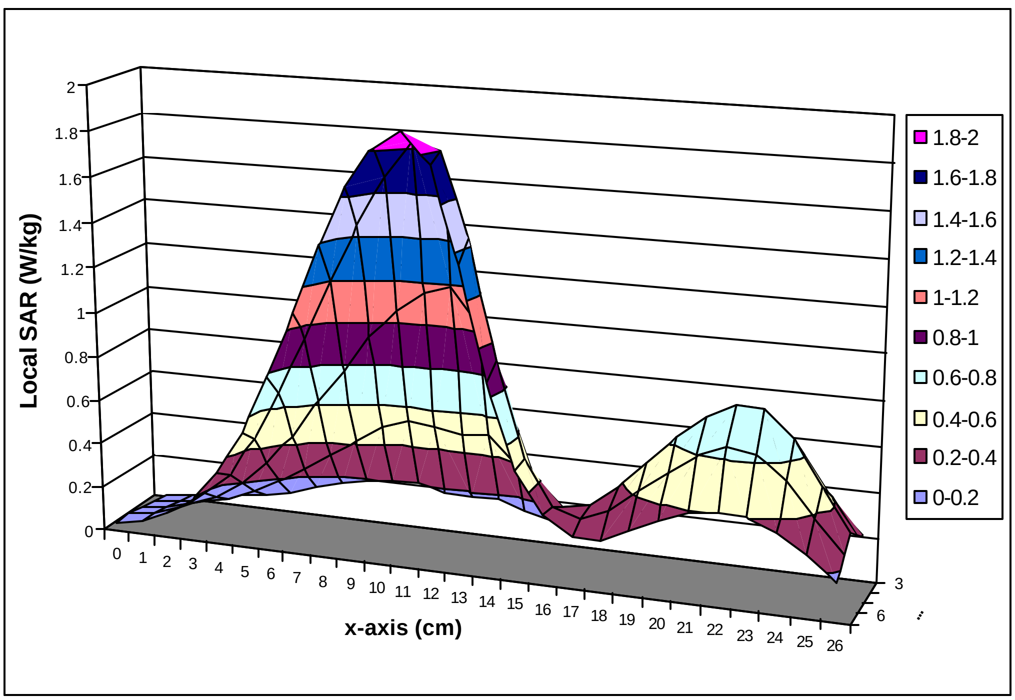
51 Spectrum Way
Nepean, Ontario, K2R 1E6

Tel. (613) 820-2730
Fax (613) 820 4161
e-mail: info@aprel.com

APPENDIX E

Validation Scans





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